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ABSTRACT

This paper proposes that equity--including gender equity--is an integral part of the agenda of the mathematics standards, and the standards provide an important means of achieving equity. Conventional wisdom on the subject is elaborated upon and professional analysis on equal education in mathematics is provided. Issues in learning and teaching are also pointed out, especially cooperative learning. This paper concludes with the idea that if politicians and education leaders accept the challenge of rigorous standards for all children, if parents expect as much in mathematics from their daughters as from their sons, and if teachers diversify their pedagogy to better match instruction with each student's approach to learning, then perhaps the cycle of lowered expectations can be broken. The prescription for achieving equity is to marshal consistent support for equal expectations. (ASK)

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by
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Equalizing Expectations, Achieving Equity

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An unpublished paper presented at a workshop on gender issues in science and mathematics education sponsored by the American Association for the Advancement of Science (AAAS), Seattle, April 1997.

"Equity for all requires excellence for all.
Both thrive when expectations are high."

-- *Everybody Counts*, NRC, 1989

Last month corporate executives joined the nation's Governors in an education summit to urge what President Clinton has called a "revolution of rising expectations." Seven years after President Bush and the Governors held the first education summit to set national goals for education, the Governors reconvened to reclaim leadership and re-energize the mission. This time the Governors focused not on national goals but on urging states to establish "rigorous standards" that "drive excellence."

The movement to develop education standards began just seven years ago with a grass-roots effort in mathematics. In early 1989, half a year before the first education summit, the mathematical community released two pioneering reports: the National Research Council's *Everybody Counts* and the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* . While it is too early to assess their long term impact, it is already clear that these documents have made several contributions to educational discourse that will, I believe, have lasting significance:

- They demonstrate the strategic value of national standards as a means of establishing a vision of excellence and benchmarks for performance.
- They advocate a revolutionary shift in the goal of mathematics education--from educating a scientific elite to preparing all students for life and work in the information age.
- They expose as a myth the widespread belief that success in mathematics depends on ability rather than on effort.

In the very same breath, the *Standards* establish expectations for excellence in mathematics and recommend that all students meet these expectations. The *Standards* challenge every district and every school, every principal and every teacher, to achieve what has never been accomplished in the history of mathematics education: both excellence and equity.

This challenge leads to two important observations about gender equity in mathematics: First, equity, including gender equity, is an integral part of the agenda of the mathematics *Standards*. Second, the *Standards* provide an important means of achieving equity. To accomplish their goals, the movements for gender equity and for standards must be joined in support of equal expectations

for all students.

Conventional Wisdom

As we all know, the effort to introduce educational standards has not gone smoothly--not even in the supposedly objective subject of mathematics. As an organ transplant is rejected by the defense mechanism of the body's immune system, so the mathematics standards triggered an "immune response" in a body politic that has been sensitized through generations of academic tradition and community mythology. Conventional wisdom has held that mathematics is not for everyone, but only for those--primarily boys, generally European or Asian--with a special gift. Barbie dolls used to proclaim that "math is hard"; newsmagazines talked about a "math gene." Even today many parents (and some teachers) still believe that "girls can't do math." Many also believe that mathematics is more necessary for boys than for girls because it is more often required for careers that men pursue.

Despite everyday evidence that some girls do enjoy mathematics and are very good at it, the public harbors a deep-seated belief that these girls are the exceptions that prove the rule--that generally speaking, girls can't do mathematics. This attitude is conveyed to girls at a very young age, even before they enter school, and presents extraordinary psychological impediments to success. Prevailing public opinion simply does not support the *Standards* ' claim that boys and girls alike can and should achieve excellence in mathematics.

At first glance, it appears that the weight of evidence is with the public. Boys clearly outperform girls in virtually all common indicators of mathematical performance, from SAT tests to Olympiad problems. Boys vastly outnumber girls as winners of mathematical competitions and in screening tests for mathematically talented youth. Men are more likely to take advanced and difficult mathematics courses, and are more likely to pursue careers in mathematics-based fields. Despite extraordinary efforts to attract and support mathematically talented young women, imbalances persist in virtually every indicator of mathematical performance: in standardized test scores, in competitive awards, and in course and career selection.

Readily available evidence thus appears to confirm conventional wisdom: in mathematics, girls cannot compete with boys on equal terms. Girls do not generally demonstrate as intense aptitude, interest, or commitment to mathematics as do boys. This has led those committed to gender equity in mathematics education to develop special programs for girls--for example, single-sex classes, summer math for girls, or separate competitions. Indeed, girls do thrive in special programs that insulate them--at least temporarily--from the cultural belief that "girls can't do math." Examples of such programs abound, and evidence of success is not hard to find.

But ironically, these very programs, while they enable girls to meet high standards in mathematics, also reinforce the idea that girls are not capable of competing with boys on equal terms. Even as they help girls succeed in mathematics, girls-only programs legitimize the common notion that to excel in mathematics, girls need special help. Educators committed to gender equity face a real challenge when the very programs that achieve their goals also reinforce public attitudes that make the problem worse.

Professional Analysis

As an untrained individual can easily be misled by symptoms of disease, so conventional interpretations of mathematical performance are often simplistic, or just plain wrong. Professional analysis frequently reveals insights that challenge conventional wisdom, although rarely are the data compelling or the interpretations unequivocal. Evidence concerning performance in mathematics is ambiguous, in part because the relevant factors are tightly bound to societal attitudes. The forces of nature and nurture, of individual and culture, of parents and teachers interact in complex ways that

we have barely begun to understand.

Many public misconceptions concerning gender differences are fueled by commonplace errors in inference, motivated perhaps by a natural desire to interpret evidence in ways that support preconceived ideas. First, and most common, is the confusion of correlation with causation. Test scores that show gender differences may establish correlation, but they provide no clue as to cause. Second, variability among individuals in mathematics vastly exceeds variability between genders, so inferences based on group averages do not apply to individuals. Finally, virtually all the evidence that appears to show gender differences in capability can also be seen as the natural consequence of society's negative expectations about girls' abilities in mathematics.

The fact is that gender differences in mathematical performance have diminished consistently for the last several decades. Unfortunately, the differences that make headlines (especially college-entrance tests such as SAT and AP) appear to send the opposite message--that men consistently outperform women on mathematics tests that really matter. However, test scores provide poor benchmarks for comparing mathematical performance of boys and girls:

- Small differences in test averages often reveal themselves as large differences in the extremes. Since the extremes are more visible (via awards, prizes, scholarships), the public is left with a very misleading impression of the extent of the differences. Indeed, some recent research suggests that gender differences in mathematical performance lie more in variability--boys are more likely to be found at both extremes--than in averages.

- As children, boys and girls perform equally in all aspect of mathematics, but girls fall behind in adolescence, primarily in advanced problem solving. But among students who enroll in advanced science courses that employ mathematical problem solving, this difference is much less pronounced.

- Averages reported on voluntary tests such as SAT and AP magnify gender differences by comparing means from unrepresentative samples. Differences between randomly selected samples of men and women (such as measured by NAEP) are much less pronounced.

- The context of mathematical questions influences performance in a manner that clearly correlates with gender. Mathematics questions about baseball and sewing produce distinctly gender-related results. Thus tests can magnify or diminish apparent gender differences merely by the context of questions asked.

Gender differences in enrollment in advanced mathematics courses also have diminished. Those differences that do remain appear to be associated with other factors such as career interests or technology. For example, although men and women enroll equally in advanced high school mathematics courses, gender differences persist in mathematics courses associated with fields that rely on physics, a subject that relatively few women take either in high school or in college. Similarly, although more girls are choosing to enter formerly male-dominated fields and are successfully completing the requisite mathematics courses, many women resist the "computer-jock" environment of today's technology-intensive mathematics. It will take years of work to reduce these remaining impediments to equal participation by women in all parts of mathematics education.

Learning and Teaching

Although there appear to be few if any significant differences in boys' and girls' capacities to learn mathematics, both research and practice confirm what appear to be large differences in certain behavioral variables that undoubtedly influence the way students learn mathematics. For example:

- Considerable evidence supports the notion that girls learn differently than do boys. Girls are said to favor cooperation over competition, teamwork over individualism, intuition over analysis, tentativeness over assertiveness, compromise over victory.

- Measures of aggression show large gender differences, and there is some evidence from evolutionary biology that these differences may be innate. Moreover, aggressive argumentation is often seen as a sign of mathematical prowess, and is encouraged in advanced courses that push students to achieve the highest levels of mathematical performance.

- Significant gender differences emerge in students' confidence about their mathematical ability: girls' self-confidence weakens in higher grades even when evidence of performance remains strong; boys' self-confidence grows, especially if performance is strong. Confidence is a prerequisite to persistence, which is essential to solving mathematical problems.

- Boys take risks, make guesses, follow hunches; girls learn what they are taught, and rely more on school-taught algorithms. The former strategy is often more effective in timed tests and competitive environments that favor risk-taking over careful calculation.

These gender-related characteristics represent differences, not weaknesses, and apply to groups, not individuals. Since mathematics is learned in a wide variety of ways, teachers who diversify their pedagogy in response to these differences will enable girls and boys to learn on equal terms.

Too often, we infer from observed differences in styles of learning imagined differences in capacity to learn. Teachers, women as well as men, are not immune to the expectation of lower performance that the public sets for girls' study of mathematics. Many studies have shown that teachers generally expect less of girls. Thus girls' work is not taken as seriously, they receive less attention and little encouragement, and their mathematical ideas are not adequately acknowledged. Boys are given more chances to get things right--since teachers believe they can--whereas girls' shortcomings are accepted since they are believed to be innate. Boys get the message of the *Standards* --that mathematics can be learned through hard work. Girls get the public myth--that success in mathematics depends primarily on ability.

It is easy to underestimate the debilitating impact on girls and young women of a society saturated with signals that girls are out of place in mathematics. People tend to behave in ways that reflect what is expected of them. Many young girls are willing, sometimes even encouraged, to perform so as to confirm the stereotype that girls can't do mathematics--since it is both psychologically and socially easier to conform than to challenge the stereotype. To challenge and fail is to confirm one's inability; to challenge and succeed is to risk peer pressure that disparages girls' success in mathematics. To break the cycle of stereotype and lowered expectations requires an environment in which expectations can be raised without risking humiliation or embarrassment.

Cooperative Learning

One common response to the challenge of gender equity is to encourage students to construct their knowledge of mathematics through cooperative learning. Researchers document the value of group work as a strategy for engaged, active learning. Employers implore teachers to prepare students to function as part of a team. And teachers report many positive benefits from group activities, including increased peer support and students' increased pride in their work. For these and other reasons, the NCTM *Standards* urge greater use of cooperative learning and constructivist methods. Cooperative learning not only enables more girls to succeed in mathematics, but also supports improved mathematics learning by minorities and by large numbers of majority males who have been turned off to mathematics by traditional classroom methods. Cooperative learning seems to be a winning idea for all, and an ideal approach to achieving gender equity.

Surprisingly, however, cooperative learning is often seen as a virus invading the body of school mathematics. Its presence mobilizes parental defense mechanisms to contain the outbreak and prevent its spread. Many parents believe that group learning is both unsound and unfair, particularly in a subject such as mathematics whose mastery is widely recognized as an individual achievement. Exploratory projects and team efforts, many believe, rely too heavily on children learning from each other rather than from an expert (the teacher). Cooperative learning is seen as watering down traditional expectations by letting some children get by on other children's efforts. The result, many parents believe, is inefficient instruction and unfair grading. Unfortunately, since cooperative learning is often advocated on the grounds that it is more suited to girls' "learning style," hostility to this method reinforces public beliefs that equity for girls can only be achieved at the expense of rigor.

As if that weren't enough, many mathematicians, scientists, and engineers fear that by focusing on "mathematics for all," standards-inspired programs will not adequately prepare students for the rigors of advanced scientific study. They worry that open-ended projects and group processes will suppress rigor in favor of a naive notion of fairness--that all ideas are of equal merit. Moreover, they fear that cooperative work set at a level that can be achieved by all students will inhibit able children from developing high levels of expectations and rigor.

Fortunately, the argument for cooperative work rests in part on evidence from industry that effective teams can reach higher standards than can individuals working alone. The challenge for education, and particularly for gender equity, is to realize these gains in the classroom by ensuring that cooperative activities really do lead to rigorous learning.

Equalizing Expectations

The vision of equity proclaimed in the NCTM *Standards* represents a mixture of evidence and belief--evidence of best practice combined with belief in a vision of excellence for all. Much of the public concern about on-going adaptations of the *Standards* in diverse communities centers not on disputes about whether the recommended means will accomplish the stated ends, but about whether the ends themselves are really appropriate. Nowhere is this concern expressed more sharply than in the ostensible clash between equity and excellence.

Rhetoric from the Governors' education summit emphasizes expectations and rigor: set the standards high, and all will achieve more. The risk in this rhetoric is that "high standards" means different things to different people. For some the slogan signifies "education for all"--the message of the science and mathematics Standards. For others, "high standards" signals a return to the tradition of elite education--of mathematics for future scientists and engineers. And for yet others, the phrase seems to suggest a return to "basics." "If you can't calculate," said one Governor at the recent summit, "you should not get a diploma."

If standards are viewed as a vision of excellence for all students not only in content but also in pedagogy and assessment, then a focus on standards is indeed the best way to ensure gender equity. In particular, the mathematics *Standards*

- Advocate a high level of achievement for all students.
- Encourage active pedagogy and student interaction.
- Recommend a three-year core curriculum for all high school students.
- Promote variety in instruction to suit each child's needs.
- Embed mathematics in contexts that make it relevant for all.

Any classroom inspired by these objectives will offer girls--and others--effective, hospitable, and

equitable opportunities in which to learn mathematics.

The goal of equity must be excellence for all. This requires setting high standards for all, and creating classroom environments in which all can learn. The message of the Governors' education summit is that responsibility for pursuing this agenda now rests with the states: Governors, chief state school officers, and other officials must ensure that state frameworks embody both the goals and the expectations of the*Standards*. High expectations will surmount the stereotype that girls "can't do math" and at the same time provide sufficient rigor to satisfy both mathematicians and politicians.

If politicians and education leaders accept the challenge of rigorous standards for all children, if parents expect as much in mathematics from their daughters as from their sons, and if teachers diversify their pedagogy to better match instruction with each student's approach to learning, then perhaps the cycle of lowered expectations can be broken. The prescription for achieving equity is to marshal consistent support for equal expectations.

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